UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/589,852	11/27/2006	Noboru Ichinose	PHKF-05004US	3677

21254 7590 02/10/2009

MCGINN INTELLECTUAL PROPERTY LAW GROUP, PLLC
8321 OLD COURTHOUSE ROAD
SUITE 200
VIENNA, VA 22182-3817

EXAMINER	
WHALEN, DANIEL B	

ART UNIT	PAPER NUMBER
2829	

MAIL DATE	DELIVERY MODE
02/10/2009	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	10/589,852	ICHINOSE ET AL.	
	Examiner	**Art Unit**	
	DANIEL WHALEN	2829	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE _3_ MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on _20 October 2008_.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) _1,4,5,8 and 14-27_ is/are pending in the application.

4a) Of the above claim(s) _14 and 15_ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) _1,4,5,8,16-27_ is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _09/18/08,10/20/08_.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 102

1. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

2. **Claims 22-23** are rejected under 35 U.S.C. 102(b) as being anticipated by Harwig et al. (“Electrical Properties of β-Ga_2O_3 Single Crystals. II,”; hereinafter “Harwig”).

3. **Re Claims 22 and 23**, Harwig teaches a method of controlling a conductivity of a Ga_2O_3 system single crystal, comprising:

adding (doping) a predetermined dopant to the Ga_2O_3 system single crystal (β-Ga_2O_3 single crystal) such that said dopant is substituted for Ga in the Ga_2O_3 system single crystal to obtain a desired conductivity (page 205, Introduction line 1-15, Experimental line 1-13),

wherein said predetermined dopant comprises a p-type dopant (Mg; also applies to **claim 23** for p-type dopant) for controlling a conductivity of the Ga_2O_3 system single crystal, said p-type dopant comprising one of H, Li, Na, K, Rb, Cs, Fr, Be, Mg, Ca, Sr, Ba, Ra, Mn, Fe, Co, Ni, Pd, Cu, Ag, Au, Zn, Cd, Hg, T1, and Pb, said conductivity of the Ga_2O_3 system single crystal being controlled dependently on an adding amount of said p-type dopant (fig. 1; page 205, introduction line 1-15, experimental line 1-13).

Wherein said desired conductivity is dependent upon an amount of said predetermined dopant added to said Ga_2O_3 system single crystal (fig. 1).

It is noted that one of the ordinary skill in the art would recognize that when the predetermined dopant such as p-type dopant (Mg) is doped to the Ga_2O_3 system single crystal, the dopant is substituted for Ga in the Ga_2O_3 system single crystal. Furthermore, the recitation of “said dopant is substituted for Ga in the Ga_2O_3 system single crystal” is only a statement of the inherent properties of adding the dopant (e.g. Mg) to the Ga_2O_3 system single crystal. The structure recited in Harwig is substantially identical to that of the claims, claimed properties or functions are presumed to be inherent. Or where the claimed and prior art products are identical or substantially identical in structure or composition, or are produced by identical or substantially identical processes, a prima facie case of either anticipation or obviousness has been established. See In re Best, 195 USPQ 430, 433 (CCPA 1977) and MPEP 2112.01.

Furthermore, regarding the recitation of conductivity that is dependent upon an amount of the predetermined dopant added to the Ga_2O_3 system, Harwig shows Mg 1000 and Mg 100 are showing different conductivities at the same temperature. Therefore, Harwig clearly teaches that the conductivity is dependent upon an amount of the predetermined dopant added to the Ga_2O_3 system. Additionally, even if Harwig does not explicitly disclose the conductivity dependency with the amount of dopant, one skilled in the semiconductor art would easily recognize that the concentration of either n-type dopant or p-type dopant is directly proportional to the conductivity of Ga_2O_3

system. Therefore, as the concentration of dopant varies, the concentration that dopant is implanted also varies.

Re Claim 24, Harwig teaches that said n-type dopant (Zr) comprises one of Si, Hf, Ge, Sn, Ti, and Zr.

Claim Rejections - 35 USC § 103

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

5. **Claims 16-18** are rejected under 35 U.S.C. 103(a) as being unpatentable over Harwig in view of Harwig et al. ("Electrical Properties of β-Ga_2O_3 Single Crystals. II,"; hereinafter "Harwig").

6. **Re Claims 16 and 17**, Harwig teaches a method of controlling a conductivity of a Ga_2O_3 system single crystal, comprising:

adding (doping) a predetermined dopant to the Ga_2O_3 system single crystal (β-Ga_2O_3 single crystal) such that said dopant is substituted for Ga in the Ga_2O_3 system single crystal to obtain a desired conductivity (page 205, Introduction line 1-15, Experimental line 1-13),

wherein said predetermined dopant comprises a p-type dopant (Mg; also applies to **claim 17** for p-type dopant) for controlling a conductivity of the Ga_2O_3 system single crystal, said p-type dopant comprising one of H, Li, Na, K, Rb, Cs, Fr, Be, Mg, Ca, Sr,

Ba, Ra, Mn, Fe, Co, Ni, Pd, Cu, Ag, Au, Zn, Cd, Hg, T1, and Pb, said conductivity of the Ga_2O_3 system single crystal being controlled dependently on an adding amount of said p-type dopant (fig. 1; page 205, introduction line 1-15, experimental line 1-13).

It is noted that one of the ordinary skill in the art would recognize that when the predetermined dopant such as p-type dopant (Mg) is doped to the Ga_2O_3 system single crystal, the dopant is substituted for Ga in the Ga_2O_3 system single crystal. Furthermore, the recitation of “said dopant is substituted for Ga in the Ga_2O_3 system single crystal” is only a statement of the inherent properties of adding the dopant (e.g. Mg) to the Ga_2O_3 system single crystal. The structure recited in Harwig is substantially identical to that of the claims, claimed properties or functions are presumed to be inherent. Or where the claimed and prior art products are identical or substantially identical in structure or composition, or are produced by identical or substantially identical processes, a prima facie case of either anticipation or obviousness has been established. See In re Best, 195 USPQ 430, 433 (CCPA 1977) and MPEP 2112.01.

Although Harwig discloses the purity of Ga_2O_3 system single crystal is 4N (pg. 205, Experiment, Alusuisse 99.99%), Harwig does not explicitly disclose that the purity of Ga_2O_3 system single crystal is 6N. Nevertheless, one of ordinary skill in the art would recognize that 6N of Ga_2O_3 is more pure than 4N of Ga_2O_3 by optimizing the gas flow and therefore 6N has an improved electrical property by having less impurity in the system compared to 4N of Ga_2O_3. Therefore, it would have been obvious to one of ordinary skill in the art to optimize the Ga_2O_3 system to have the purity of 6N over 4N for improved electrical property with less impurity in the system.

Re Claim 18, Harwig teaches that said n-type dopant (Zr) comprises one of Si, Hf, Ge, Sn, Ti, and Zr.

7. **Claims 1, 4, and 5** are rejected under 35 U.S.C. 103(a) as being unpatentable over Harwig in view of Ueda et al. ("Synthesis and control of conductivity of ultraviolet transmitting β-Ga_2O_3 Single Crystal"; hereinafter "Ueda").

8. **Re Claim 1**, Harwig teaches a method of controlling a conductivity of a Ga_2O_3 system single crystal, comprising:

Adding (doping) a predetermined dopant to the Ga_2O_3 system single crystal such that said dopant is substituted for Ga in the Ga_2O_3 system single crystal to obtain a desired conductivity (page 205, introduction line 1-15, experimental line 1-13),

wherein said predetermined dopant comprises one of:

a n-type dopant (Zr) for decreasing a resistance of the Ga_2O_3 system single crystal, said conductivity of the Ga_2O_3 system single crystal being controlled dependently on an adding amount of said n-type dopant (fig. 1; page 205, introduction line 1-15, experimental line 1-13); and

a p-type dopant (Mg) for increasing a resistance of the Ga_2O_3 system single crystal, said conductivity of the Ga_2O_3 system single crystal being controlled dependently on an adding amount of said p-type dopant (fig. 1; page 205, introduction line 1-15, experimental line 1-13).

However, Harwig does not disclose that the predetermined dopant comprises one of: the n-type dopant comprising one of Si, Hf, Ge, Sn, and Ti; and the p-type

dopant comprising one of H, Li, Na, K, Rb, Cs, Fr, Be, Ca, Sr, Ba, Ra, Mn, Fe, Co, Ni, Pd, Cu, Ag, Au, Zn, Cd, Hg, Tl, and Pb. Ueda discloses adding the dopants such as Sn to the Ga_2O_3 single crystal to control the conductivity (page 1361). Therefore, it would have been obvious to one of the ordinary skill in the art at the time of the invention to combine the teaching of Harwig with that of Ueda as Sn as readily available n-type dopant to the Ga_2O_3 single crystal.

It is noted that one of the ordinary skill in the art would recognize that when the predetermined dopant such as n-type dopant (Zr) or p-type dopant (Mg) is doped to the Ga_2O_3 system single crystal, the dopant is substituted for Ga in the Ga_2O_3 system single crystal. Furthermore, the recitation of “said dopant is substituted for Ga in the Ga_2O_3 system single crystal” is only a statement of the inherent properties of adding the dopant (e.g. Zr/Mg) to the Ga_2O_3 system single crystal. The structure recited in Harwig is substantially identical to that of the claims, claimed properties or functions are presumed to be inherent. Or where the claimed and prior art products are identical or substantially identical in structure or composition, or are produced by identical or substantially identical processes, a prima facie case of either anticipation or obviousness has been established. See In re Best, 195 USPQ 430, 433 (CCPA 1977) and MPEP 2112.01.

Although Harwig discloses the purity of Ga_2O_3 system single crystal is 4N (pg. 205, Experiment, Alusuisse 99.99%), Harwig does not explicitly disclose that the purity of Ga_2O_3 system single crystal is 6N. Nevertheless, one of ordinary skill in the art would recognize that 6N of Ga_2O_3 is more pure than 4N of Ga_2O_3 by optimizing the gas flow

and therefore 6N has an improved electrical property by having less impurity in the system compared to 4N of Ga_2O_3. Therefore, it would have been obvious to one of ordinary skill in the art to optimize the Ga_2O_3 system to have the purity of 6N over 4N for improved electrical property with less impurity in the system.

Re Claims 4 and 5, teaching of Harwig and Ueda has been discussed above. However, the combined teaching is silent as to describing numerical values of the resistivity and a carrier concentration. It is noted that the combined teaching teaches an identical process, such as doping a predetermined dopant to the Ga_2O_3 system single crystal, and an identical material, such as n-type dopant. Therefore, a value of 2.0×10^{-3} to 8.0×10^{2} Ωcm as the desired resistivity by adding the n-type dopant and a carrier concentration within a range of 5.5×10^{15} to 2.0×10^{19} Ωcm are obtained. MPEP 2112.01.

Furthermore, applicant should note that it has held that discovering an optimum value of a result effective variable involves only routine skill in the art. *In re Boesch*, 617 F.2d 272, 205 USPQ 215 (CCPA 1980).

9. **Claim 8** is rejected under 35 U.S.C. 103(a) as being unpatentable over Harwig and Ueda as applied to claim 1 above, and further in view of Ichinose et al. (US 2004/0007708 A1; hereinafter “Ichinose”).

Re Claim 8, teaching of Harwig and Ueda has been discussed above including controlling the electrical conductivity of the Ga_2O_3 system single crystal. However, although Harwig discloses doping Mg as the p-type dopant (Introduction), the combined

teaching does not explicitly disclose p-type dopant comprising one of H, Li, Na, K, Rb, Cs, Fr, Be, Ca, Sr, Ba, Ra, Mn, Fe, Co, Ni, Pd, Cu, Ag, Au, Zn, Cd, Hg, Tl, and Pb. Ichinose discloses adding the p-type dopant such as zinc (Zn) to Ga_2O_3 single crystal (page 2). Therefore, it would have been obvious to one of the ordinary skill in the art at the time of the invention to combine the teaching of Harwig and Ueda regarding controlling the resistivity (resistivity is simply the reciprocal of its conductivity) with that of Ichinose regarding doping p-type dopant such as Zn as it is readily available p-type dopant material choice to the Ga_2O_3 single crystal to obtain the desired resistivity. It is noted that the combined teaching of Harwig, Ueda, and Ichinose teaches an identical process, such as doping the predetermined dopant to the Ga_2O_3 system single crystal, and an identical material, such as the p-type dopant. Therefore, a value of 1×10^3 Ωcm or more as the desired resistivity by adding the p-type dopant are obtained. MPEP 2112.01.

Furthermore, applicant should note that it has held that discovering an optimum value of a result effective variable involves only routine skill in the art. *In re Boesch*, 617 F.2d 272, 205 USPQ 215 (CCPA 1980).

10. **Claims 19-21 and 25-27** are rejected under 35 U.S.C. 103(a) as being unpatentable over Harwig.

Re Claims 19-21 and 25-27, teaching of Harwig has been discussed above. However, Harwig is silent as to describing numerical values of the resistivity and a carrier concentration. It is noted that Harwig teaches an identical process, such as

doping a predetermined dopant to the Ga_2O_3 system single crystal, and an identical material, such as n-type dopant and the p-type dopant. Therefore, a value of 2.0 X 10^{-3} to 8.0 X 10^{2} Ωcm as the desired resistivity by adding the n-type dopant, a carrier concentration within a range of 5.5 × 10^{15} to 2.0 X $I0^{19}$ Ωcm, and 1 X 10^{3} Ωcm or more as the desired resistivity for adding p-type dopant are obtained. MPEP 2112.01.

Furthermore, applicant should note that it has held that discovering an optimum value of a result effective variable involves only routine skill in the art. *In re Boesch*, 617 F.2d 272, 205 USPQ 215 (CCPA 1980).

Response to Arguments

11. Applicant's arguments with respect to amended claims have been considered but are moot in view of the new ground(s) of rejection as set forth above in the Office Action.

Conclusion

12. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not

mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to DANIEL WHALEN whose telephone number is (571)270-3418. The examiner can normally be reached on Monday-Friday, 7:30am to 5:00pm, EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Ha Nguyen can be reached on (571) 272-1678. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for

published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/D. W./

Examiner, Art Unit 2829
01/28/2009

Daniel Whalen
/Michael S. Lebentritt/

Primary Examiner, Art Unit 2829